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The Glacial Geology of Northern Vermont

Baldwin, Brewster

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David P. Stewart *

INTRODUCTION

For the past six field seasons, the writer has participated in a surface mapping program under the joint sponsorship of the Vermont Geological Survey and the Vermont Highway Department. The work has been under the direct supervision of Dr. Charles G. Doll, the State Geologist. During this time, fourteen quadrangles covering approximately twenty percent of the total area of the state have been mapped.

Insofar as the northern section of Vermont is concerned, the major portion of the work has been in the Montpelier-Burlington Region, and this is the area to be covered by the two field trips.

It has been established that at least two late Wisconsin ice invasions covered the northeastern section of Vermont. The most recent of these invaded the Champlain Lowland from the northwest, crossed the Green Mountains and lapped upon the western flanks of the Worcester and Elmore mountains in the Stowe area.

South of the Winooski River the margin of this ice sheet is not too well marked but it seems probable that the ice moved into the Dog River valley. All of the surface till in the Champlain Valley and the Mt. Mansfield-Camels Hump region thus far mapped was deposited by this ice episode. The ice mass has been designated the Burlington lobe and the till it deposited, the Burlington till (Stewart, 1961).

The striations on the bedrock in the Montpelier Quadrangle east of Worcester Mountain and in the Barre Quadrangle east of the Dog River indicate that the last ice to cover this region came from the northeast. A dark grey, indurated till with a northeast fabric has also been found in the northern part of the Champlain Lowland. The older till has been noted at about a dozen different localities in the Burlington, Milton and St.Albans quadrangles. Here it underlies the younger, brown Burlington till. Because this till was first studied in the Shelburne area, it has been designated the Shelburne till (Stewart, 1961).

The correlation of these tills has not been definitely established. MacClintock(1958) has mapped two tills in the St. Lawrence Valley. The younger till from the northwest he called the Fort Covington and the older from the northeast, the Malone. MacClintock and Terasmae(1960) have correlated the Fort Covington till as Port Huron(Mankato) in age and the Malone as probably Cary. It is believed that the Burlington till is the same age as the Fort Covington in the St. Lawrence Valley and the Shelburne is the same as the Malone.

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* Assistant Professor of Geology, Miami University,
Oxford, Ohio

Studies of the Lake Vermont shore deposits by the present survey have established the existence of a higher-than-Coveville stage of this lake episode. The shore phenomena of this stage have been traced from the southern border of the Burlington Quadrangle, in the vicinity of Hinesburg, to Georgia Mountain, due west of Milton. In this distance, approximately 25 miles, the shore features rise from an elevation of 695 feet to 750 feet. A higher-than-Coveville lake stage was identified in New York by Woodworth (1905) and he named it the Quaker Springs stage. Very little mention has been made of this stage since that date and it had not been identified in Vermont prior to the present survey.

The lacustrine deposits of the Montpelier and Camels Hump quadrangles have been mapped but, as yet, a complete correlation of these has not been possible. It has been proven that the three stages of Lake Vermont extended at least partway up the Winooski and the Lamoille valleys. It is believed that the lake level designated the Winooski by Fairchild(1916) and the Mansfield by Merwin(1908) may be the Quaker Springs stage of Lake Vermont and that this lake extended up the Winooski River to Montpelier and the Lamoille River to Morrisville. The extent of the earlier stages of Lake Vermont, the Fort Ann and the Coveville, was described by Chapman(1937).

How many lake levels higher than the Quaker Springs that occured in the Winooski valley is not exactly known. There seems to be a lake strand slightly higher than the Quaker Springs but this has not been traced to determine its full extent. The elevations of the shore phenomena range from 750 to 775 feet. It is possible that this was the level instead of the Quaker Springs that Merwin(1908) called Lake Mansfield.

Another lake level seems to occur between 800 and 850 feet in the Winooski, Stowe and Lamoille valleys. This lake has not been noted in the literature nor has it been definitely outlined by the present survey.

In the North Branch valley, north of Montpelier, evidence for a lake 1000 to 1050 feet in elevation seems to occur in the form of small deltas along tributary streams 3 to 6 miles north of Montpelier and lacustrine sands in the main valley. These deposits, however, have not been traced to any other part of the Winooski valley. It is possible that this lake level correlates with that named Lake Montpelier by Fairchild(1916) in spite of the fact that both Fairchild(1916) and Merwin(1908) did not believe that the waters of this lake stood above 900 feet.

The highest lake yet found in this region is in the Stowe valley. This lake is manifested by shore phenomena northwest of Stowe on West Hill and southeast of Morrisville on Elmore Mountain. In this area, the shore features range in elevation from 1150 to 1200 feet. This is no doubt the same strand as that which C.H. Hitchcock(1908) correlated with one stage of Glacial Lake Memphremagog. Whether or not these shore phenomena can be actually traced into the Memphremagog basin is yet to be seen. It is now believed that the lake was held at this high level by the ice of the Burlington lobe when it lapped upon the western flank of the Worcester Mountains south of Stowe and it may have drained around this ice and into a lower lake in the Winooski valley through Middlesex Notch.

The gravel terraces in the Hinesburg section of the Burlington quadrangle have been of much interest to geologists. The origin of these deposits has been debated and several genetic classifications have been suggested. The two most popular beliefs have been that the gravel was a delta deposit built into Lake Vermont by Hollow Brook or that they were kame terraces. The

present survey has determined that the gravel was originally deposited as kame terraces, and that the top surfaces and the ice-contact slopes have been subsequently modified by the wave action of the Quaker Springs and Coveville stages of Lake Vermont.

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TRIP C-1

The Glacial Geology of Northern Vermont --

Part I, The Burlington Region

Leader: D.P. Stewart

LUNCH: Box lunches will be needed for this trip and should be arranged for at the registration desk.

MAPS: The trip includes areas covered by the Montpelier, Camels Hump, Mt. Mansfield, Milton and Burlington Quadrangles. Copies of the surface geology map of the Montpelier, Camels Hump and Burlington quadrangles are included in the field trip guide. The Mt.Mansfield quadrangle has not been mapped. The trip makes two stops in the extreme southwest corner of this sheet. There are no stops in the Milton Quadrangle.

START: The party will board a bus in front of the Pavilion Hotel, Montpelier, at 7:30 a.m., Saturday, October 14, 1961.

MILES

0 The bus will depart from Montpelier via the new Inter-state Highway and U.S. Route 2 to Richmond. From Richmond the route turns north to Jericho Center and Underhill Flats and thence west to Jericho. There are numerous interesting cuts along the new Interstate Highway to Waterbury (Montpelier Quadrangle). Most of these, however, have been grassed over. Between Waterbury and Richmond (Camels Hump Quadrangle), the road-work is in progress, but we do not stop here. The terraces along this route are mostly lacustrine. A typical cut 100 feet high will have 40 to 50 feet of varved clay below 50 to 60 feet of lacustrine sand. It has not been definitely established just how many lake levels are represented here in the Winooski valley. Three lake stages of Lake Vermont undoubtedly extended at least partway up the valley and one or two higher lakes occupied the valley before the Champlain Lowland was clear of ice.

North of Richmond (after leaving U.S. Route 2) the road climbs to the top of a sandy delta (elevation approximately 500 feet) that was built into the Fort Ann Stage of Lake Vermont (Chapman, 1937). Above the sand, till and bedrock cover the hill to the top (2 miles north of Richmond) where a second lacustrine terrace stands at an elevation of about 700 feet. A small pit in the lake sand can be observed on the left at the top of the hill.

Beyond the lake terrace, the road rises to the top of a kame terrace (2½ miles north of Richmond) and follows this deposit for about four miles. The road dips into a stream valley and the kame gravel can be seen on the left. The kame and kettle topography of the summit of the kame is well developed beyond the stream valley, and the bus will stop for five minutes so that those who wish can take a closer look at a kettle.

Jericho Center is built on a deposit of beach gravel and the bus will stop just beyond the village so that all can see the beach ridges on the right of the road. There are no openings in these gravels at the present time. One and one-quarter miles north of Jericho Center, the route crosses the Lee River and lake sands form the low terraces north of the river.

At Route 15, (Mount Mansfield Quadrangle) the tour will turn right and make a swing up to Underhill Flats and back so as to see the lacustrine terraces to the east of the highway before going west to STOP I. Kame terraces can also be seen to the north of Underhill Flats.

37.4 STOP I -- Gravel pit in lacustrine beach gravel (20 minutes)

STOP II - Gravel pit in lacustrine beach gravel (40 minutes)

STOPS I and II are gravel pits in the same deposit that are actually about two-tenths of a mile apart. Since the bus can drive into both pits, however, the party will board the bus at STOP I and go to STOP II. The size of the pit at STOP I gives an appreciation of the extent and depth of the deposit. The structures are much better at STOP II. The highest bar in this area is 725 feet in elevation.

The high-level lake deposits seen in this area have now been proven to be a pre-Coveville stage of Lake Vermont. These deposits (in the Jericho Center-Underhill area) were studied by the present survey in 1959. They have since been traced to the southern end of the Burlington Quadrangle (the southern limit of the survey) and as far north as Georgia Mountain, due west of Milton. This lake stage was designated the Quaker Springs by Woodworth(1905).

From STOP II the bus will continue west on Route 15 to Essex Junction (Milton and Burlington quadrangles).

From Jericho to Butlers Corners (about 4 miles) the road follows the sandy plain of the Winooski delta built into the Fort Ann Stage of Lake Vermont (Chapman, 1937). Beyond Butlers Corners (to Essex Junction) the surface material is lacustrine clay.

46.5 STOP III -- The Drury Brick-yard clay pit (30 minutes)

Brown clay over grey clay (both lacustrine) are exposed in the pit. In some places, there seems to be a pebbly material at the contact of the two colors. It has not been possible, however, to prove that the grey and the brown represent different lake stages. The brick-yard has been operated at this location for over 90 years by the Drury family. The original clay pit was at the present site of the kilns. A dense blue-grey till underlies the clay.

From STOP III the route goes south to U.S. Route 2 and then west to Spear Street in Burlington and follows Spear Street south for approximately 2½ miles to Swift Street. The route turns west on Swift Street to U.S. Route 7 and thence south to Shelburne.

Route 2A crosses the Winooski River one mile south of Essex Junction. From this point to Swift Street in Burlington, the level, sandy surface is the Delta of the Winooski River built into the Champlain Sea (Chapman, 1937). A large pit in the marine sand is located at the point where the route joins U.S. Route 2. The top of the delta in this area ranges from 300 to 340 feet in elevation.

The intersection of Spear and Swift streets is just above the marine shore. About one-tenth mile after turning west on Swift street, the street descends the old shore cliff. The terrace is well developed at this point and the bus will stop here long enough for everyone to see the cliff. Those that wish may get off the bus. The elevation at the base of the cliff is 330 feet.

62.8 STOP IV -- Two tills in stream channel (30 minutes)

Here in a small stream valley a brown till is exposed over a dark

grey till. The fabric of the brown till is northwest whereas the fabric of the black till is northeast. This is one of about a dozen where the two tills have been found exposed together. The brown till was exposed in the excavation for the new dormitory at the intersection of U.S. Route 2 and Spear Street in Burlington. The younger brown till has been designated the Burlington and the older till the Shelburne (Stewart, 1961).

The exact age of the two tills has not been definitely established. MacClintock(1958) described a younger till in the St.Lawrence Valley that he called the Fort Covington and an older till that he designated the Malone. The Fort Covington till was deposited by ice from the northwest and the Malone by ice from the northeast. These two tills have been tentatively correlated as Mankato(Port Huron) and pre-Mankato, probably Cary, respectively (MacClintock and Terasmae, 1960).

It is believed that the Burlington and Shelburne tills will correlate with the Fort Covington and Malone tills of the St.Lawrence Valley(Stewart, 1961).

STOP V -- Lunch(45 minutes)

After lunch, the tour will continue south on U.S. Route 7 to the foot of Jones Hill(3.4 miles) thence east on the Charlotte-Hinesburg road to East Charlotte(2.3 miles) and then south for a distance of 2.3 miles.

The route here crosses the lake plane of Lake Vermont. The surface material is a bouldery lacustrine clay. The source of the boulders is probably two-fold: (1) They were ice rafted and (2) they are residuals from underlying till.

70.8 STOP VI -- Stream cut along Lewis Creek two and three-quarter miles northeast of North Ferrisburg (one hour)

This stream cut probably contains more glacial geology than any other exposure in northwestern Vermont. It is not possible at this time to give a complete explanation of all that occurs here.

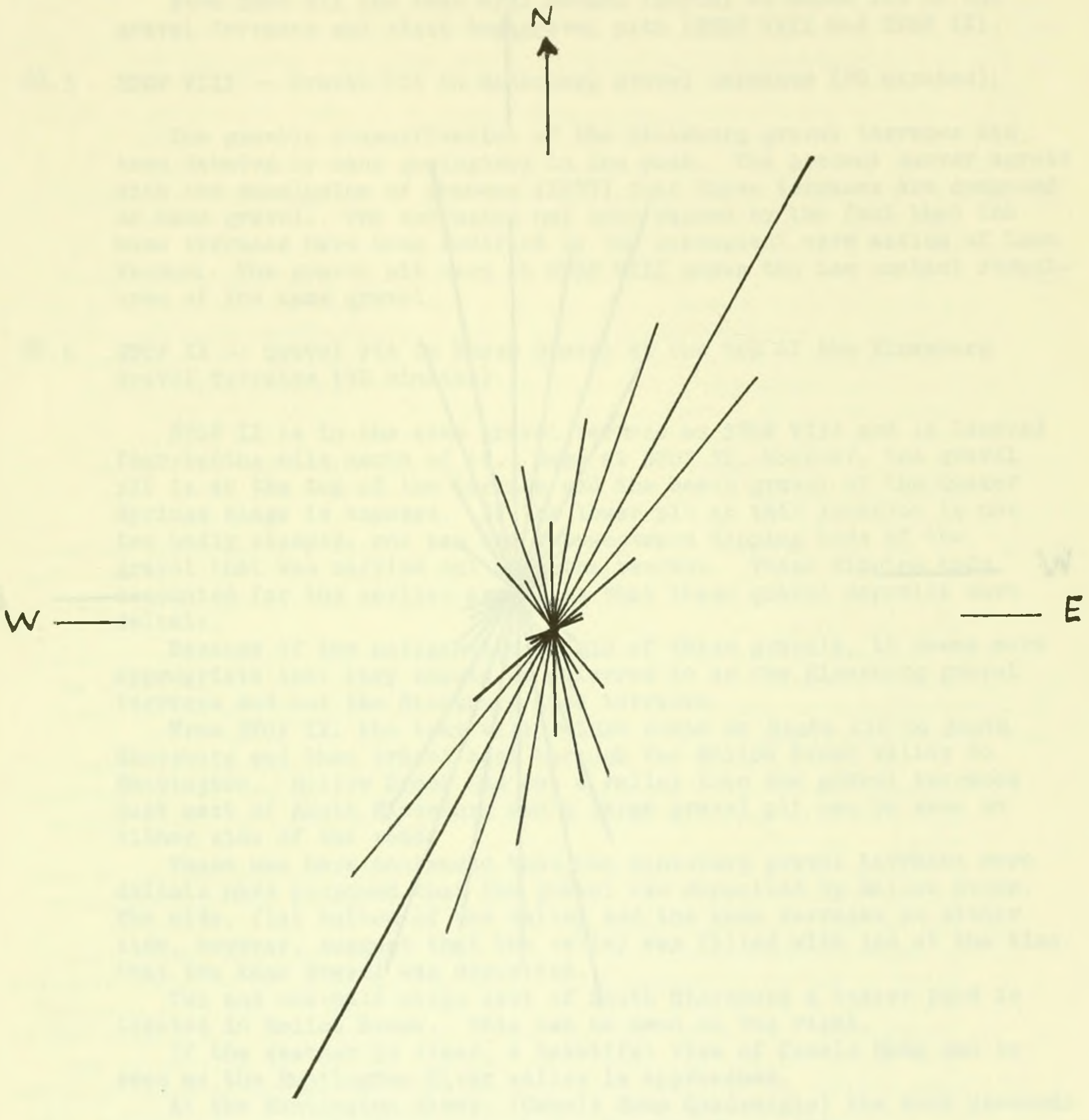
The two tills seen at STOP IV are also present in this cut. Overlying the brown till are the brown lacustrine clays of Lake Vermont.

The most interesting aspect of this cut, however, is the occurrence of an older varved clay that is overlain by the Burlington till. It is assumed that the lake that deposited the varves followed the retreat of the ice that deposited the Shelburne till. To the writer's knowledge, this is the only reported occurrence of a pre-Lake Vermont lacustrine deposit in the Champlain valley. The contact of the varves and the overlying till is interesting inasmuch as the varves are distorted at the top and some varved material has been forced up into the overlying till.

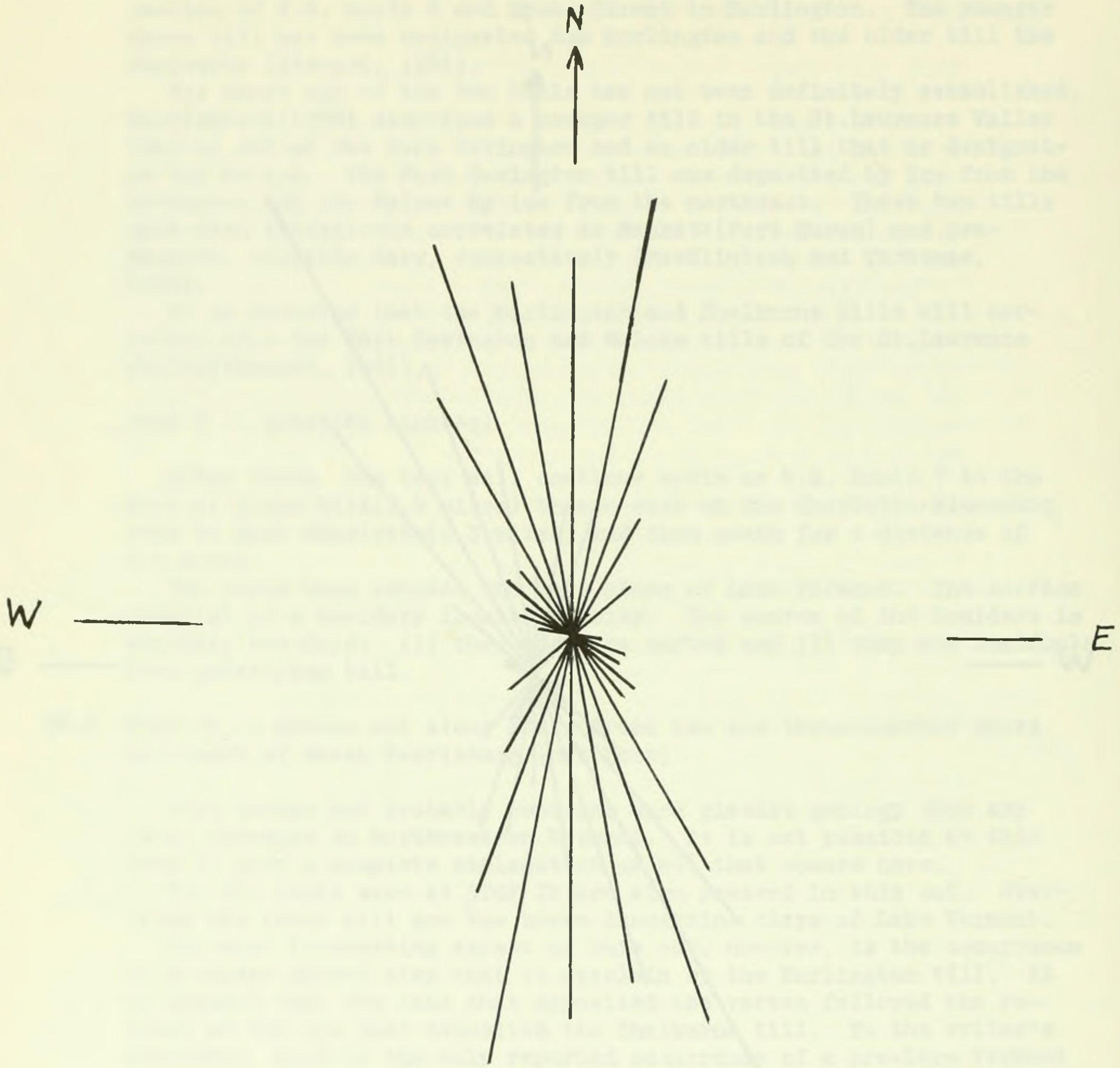
From STOP VI the bus will return to East Charlotte and proceed east on the Charlotte-Hinesburg road to Route 116 at Hinesburg. Thence we go south on Route 116 for a distance of 7.3 miles to STOP VII. In this distance we pass by the Hinesburg gravel terraces and several gravel pits can be seen from the road. The tour will return to two of these pits.

84.2 STOP VII -- The Quaker Springs shore and the Hinesburg gravel terraces (15 minutes)

Looking south from STOP VII one can see the Quaker Springs shore



Fabric of the Shelburne Till. Taken along a stream channel one and one-half miles south of Shelburne Village (Stop IV).



Fabric of the Burlington Till. Taken from excavation for University of Vermont Residence Hall at U. S. Route 2 and Spear Street in Burlington Striations on the bedrock under the Till Trend N15°W to N30°W.

terraces at an elevation of 695 feet. The shore features can be traced northward to the top of the Hinesburg gravel terraces. Looking north from STOP VII, the level tops of the gravel terraces can be noted.

From STOP VII the tour will return (North) on Route 116 to the gravel terraces and visit two gravel pits (STOP VIII and STOP IX).

88.3 STOP VIII -- Gravel Pit in Hinesburg Gravel terraces (20 minutes).

The genetic classification of the Hinesburg gravel terraces has been debated by many geologists in the past. The present survey agrees with the conclusion of Chapman (1937) that these terraces are composed of kame gravel. The confusion has been caused by the fact that the kame terraces have been modified by the subsequent wave action of Lake Vermont. The gravel pit here at STOP VIII shows the ice contact structures of the kame gravel.

88.6 STOP IX -- Gravel Pit in Beach Gravel at the top of the Hinesburg Gravel Terraces (30 minutes).

STOP IX is in the same gravel terrace as STOP VIII and is located four-tenths mile north of it. Here at STOP IX, however, the gravel pit is at the top of the terrace and the beach gravel of the Quaker Springs stage is exposed. If the lower pit at this location is not too badly slumped, one can see the westward dipping beds of the gravel that was carried out over the terrace. These dipping beds accounted for the earlier arguments that these gravel deposits were deltaic.

Because of the polygenetic origin of these gravels, it seems more appropriate that they should be referred to as the Hinesburg gravel terraces and not the Hinesburg kame terraces.

From STOP IX, the tour will return south on Route 116 to South Hinesburg and then travel east through the Hollow Brook valley to Huntington. Hollow Brook has cut a valley into the gravel terraces just east of South Hinesburg and a large gravel pit can be seen on either side of the road.

Those who have contended that the Hinesburg gravel terraces were deltaic have proposed that the gravel was deposited by Hollow Brook. The wide, flat bottom of the valley and the kame terraces on either side, however, suggest that the valley was filled with ice at the time that the kame gravel was deposited.

Two and one-half miles east of South Hinesburg a beaver pond is located in Hollow Brook. This can be seen on the right.

If the weather is clear, a beautiful view of Camels Hump can be seen as the Huntington River valley is approached.

At the Huntington River, (Camels Hump Quadrangle) the tour proceeds down stream on the Huntington River Road to Jonesville.

Trout fishermen note the cool, clear water of the Huntington River.

98.2 STOP X -- The Huntington River Gorge (30 minutes, if we aren't running late)

The Huntington Gorge was carved by the pothole action of the Huntington River. The potholes are numerous and of various sizes.

From STOP X the tour proceeds to Jonesville and east on U. S. Route 2 and the Interstate Highway to Montpelier.

STOP XI -- Montpelier